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EXPERIMENTAL STUDY ON SIMILARITY PARAMETERS

Abstract

This study presents a comprehensive experimental investigation into the effects of primary similarity parameters—geometric, kinematic, and dynamic—on fluid flow behavior in controlled conditions. Similarity parameters are fundamental in fluid mechanics, as they establish a basis for scaled-down models that replicate the dynamics of full-scale systems. Accurate application of these parameters allows experiments to simulate real-world flow characteristics, offering valuable insights for fields such as engineering, aerodynamics, and environmental science. By establishing similarity in experimental models, researchers can analyze complex fluid behaviors in a cost-effective, manageable way, advancing both theoretical knowledge and practical applications.

In this study, a similarity analysis was conducted between gaseous hydrogen (GH2) and gaseous nitrogen (GN2) to model real flight conditions. Dynamic similarity was achieved by keeping Reynolds and Mach numbers consistent for both gases. While GH2 serves as the actual flight medium, GN2 was used in ground calibration tests as a substitute to replicate these conditions accurately. Due to the significantly lower molecular weight and higher diffusivity of GH2 compared to GN2, careful parameter matching was necessary to ensure equivalent flow behavior. Geometric similarity was maintained by using identical setups for both GH2 and GN2, enabling GN2 to reliably simulate the behavior of GH2 under controlled experimental conditions. This approach supports improved accuracy and reliability in fluid dynamic simulations, advancing research across various engineering and scientific domains.